

FURTHER OBSERVATIONS ON THE TREATMENT
OF PARALYTIC TALIPES CALCANEUS, BY
ASTRAGALECTOMY AND BACKWARD DIS-
PLACEMENT OF THE FOOT.*

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TALIPES CALCANEUS is the most disabling of the forms of paralytic talipes because it is the result of the loss of the support and propelling force of the calf muscle. As the foot is drawn or forced constantly into dorsal flexion, the os calcis gradually assumes a more upright position, its posterior extremity becoming inferior. Thus the projection of the heel is lost and the depth of the arch is exaggerated, this characteristic cavus being more extreme in the cases in which the secondary plantar flexors retain their power which draws the fore foot backward without lifting the heel. In use the limb must be swung far forward in order to strike the heel fairly, thus straining and over-extending the weakened knee. The tissues of the heel bearing all the weight, become greatly hypertrophied, while the remainder of the foot having no essential function becomes simply an appendage to it. The disproportion between the posterior and anterior divisions of the foot, and in the size of the two feet, which is well marked even in the early cases as compared to other forms of paralytic deformity, is a striking illustration of the direct effect of impaired function on development. If one or more of the lateral muscles is paralyzed the foot is turned to one or the other side, and as the adductors are usually involved, the common deformity is valgus, so marked in extreme cases that weight is borne in part upon the inner malleolus.

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In the cases of simple calcaneus, the patient in locomotion might be likened to one walking on a Pirogoff stump with the added insecurity of two uncontrolled articulations, and if lateral deformity is present the foot is rather an inembrance than a support.

The description of the characteristic deformity (Calcaneo-Cavus) with or without lateral displacement, applies of course to those cases in which the foot has not been protected by mechanical support. The object of such support as applied in the more common forms of talipes in which the anterior muscles are involved is simply to prevent toe-drop, but in the class under consideration the brace must be strong enough to withstand the strain of locomotion, therefore so heavy as to be burdensome, and if lateral distortion is present satisfactory adjustment is very difficult. As a matter of observation it may be stated that for one reason or another mechanical treatment is ineffective in a large proportion of the cases. Thus one more often sees the extreme degrees of this deformity than of other types, among patients of the better class.

The objects of operative intervention in cases of this character are to restore symmetry and to increase the stability and the resistance of the foot, so that light and simple apparatus may be effective in all cases and unnecessary in those of the most favorable type.

Before calling attention again to the operation which was described by me six years ago (*Am. Jour. Med. Sciences*, Nov., 1901), which has now been thoroughly tested and somewhat improved, it may be of advantage to enumerate other procedures that have been employed, in order to illustrate by contrast its relative efficiency.

First.—Reduction of deformity by force combined with division of contracted parts. This is of course preliminary to any further procedure. It is usually ineffective in advanced cases because of the absence of resistance against which the force may be exerted.

Second.—Willett's operation of shortening the Tendo-Achillis and sewing it to the neighboring parts with the aim

of opposing the resistance of the shortened tissues to the deformity, may be of value if the calf muscle retains a portion of its power, which may act to better advantage on the shortened tendon. In other instances, if the strain of locomotion is removed by the constant use of a proper brace, the resistance may lessen the deforming influence of the muscles on the anterior aspect of the leg. From the curative standpoint, even in the sense in which the term must be used in speaking of incurable weakness, it is ineffective, and if calcaneus is complicated by lateral distortion, it is contra-indicated.

Third.—Hoffa has performed the reverse of Gleich's operation for flatfoot, namely by sawing through the posterior extremity of the os calcis and displacing it upward and backward, to restore the projection of the heel, the tendo-Achillis being shortened to the desired degree. This operation has the advantage over the last that it improves the contour of the foot in addition to shortening the tendon.

Fourth.—Tendon transplantation. It is of interest to note that this operation was first employed for the relief of calcaneus by Nicoladoni, who attached the tendons of the two peronei muscles to the tendo-Achillis, with the aim of restoring its lost function. The futility of such a procedure is indicated by comparing the weight of the calf muscle (277 gms.) with that of the two muscles (40.5 gms.) that replace it, which are from their oblique direction subjected to still further mechanical disadvantage. Furthermore, as has been pointed out by Lorenz, the removal of the principal abductors is almost inevitably followed by varus deformity. It would appear then that the benefit of transplantation must be explained by restraint of unopposed muscular action, and that it is quite inefficient to prevent the deformity induced by functional use.

Fifth.—Arthrodesis. This operation is from the curative standpoint more hopeful than the others that have been mentioned, because firm ankylosis should prevent deformity and render bracing unnecessary. Unfortunately in childhood, when the bones are undeveloped, it is difficult to attain, even when the adjoining tarsal joints below and in front of the

ankle are included in the operation. Even firm ankylosis may not be sufficient to restrain deformity of the yielding bones during the growing period. Finally, the chances of success are lessened by deformity, especially of the lateral type. It would seem then that the operation is most likely to be successful, in those cases of simple calcaneus in adolescents in which the secondary deformity has been prevented by the use of braces.

One may sum up this criticism in the statement that each of the procedures has a certain merit in certain cases, particularly of the mild type, a class in which the brace treatment is a practicable alternative, and that the relative inefficiency of each becomes more apparent with the degree of deformity and disability. In cases of the advanced type there is no such alternative, if an operation can assure the removal of deformity and its subsequent prevention, at least as far as lateral distortion is concerned.

In the analysis of the deformity the adverse leverage of the foot must be considered. The calf muscle whose loss is the cause of the disability, in the exercise of its function, has to contract with a force four or five times as great as would be required under equal conditions, its strength according to Fick being about three times greater than of all the other leg muscles combined. This normal adverse leverage is estimated by comparing the distance from the centre of the ankle joint to the attachment of the tendo-Achillis with that of the metatarsophalangeal articulations. When the calf muscle is paralyzed the passive leverage or tendency toward deformity is increased by the loss of the projection of the heel and by the sole of the shoe which projects beyond the bearing surface of the fore foot.

The centres for abduction and adduction of the foot are the joints below and in front of the astragalus, and if one or more of the controlling muscles is paralyzed, lateral deformity follows. The insecurity caused directly by the paralysis and the distortions induced by use is exaggerated by the upright position of the os calcis which increases by at least a third the distance from the ankle to the bearing surface of the heel.

From this description of the mechanism of the deformity and of the attendant disability, it should be evident that the first step toward security must be the removal of the astragalus in order that the leg bones may rest securely on the solid part of the foot. The removal of the astragalus will permit backward displacement of the foot; thus the adverse leverage may be lessened or neutralized, while the restoration of the projection of the heel and the lowering of the malleoli to their proper level incidentally restore symmetry both as to the cavus and the lateral distortion. Further details in the operation are the adjustment of the malleoli and the tarsal bones in their new relations. The peronei tendons are usually divided and attached to the os calcis and the elongated tendo-Achillis is shortened to the required degree. The complete operation must be described as Astragalectomy and backward displacement of the foot (the essentials) combined with arthrodesis, tendon transplantation and tendon shortening, the accessories.

As this title is manifestly too cumbersome for use the procedure is usually classed under the author's name in the hospital records.

The steps of the operation are as follows: An Esmarch bandage having been applied, an incision is made from a point about one inch above the external malleolus midway between it and the tendo-Achillis, passing downward to the attachment of the tendo-Achillis, forward below the extremity of the malleolus and over the dorsum of the foot to the external surface of the head of the astragalus. The sheaths of the peronei tendons which are exposed at once, are opened throughout their entire length and the tendons, divided as far forward as the incision will permit, are thoroughly freed from all the attachments behind the malleolus and are drawn backward. One next divides the bands of the external lateral ligament, and the foot being somewhat adducted, the interosseous ligament is separated. On further inversion, the tissues being retracted, one may with scissors free the head of the astragalus from its attachments to the navicular, and forcibly twisting it outward, break off the cartilaginous margin to

which the internal and posterior ligaments that cannot be reached are attached. One then prepares the new articulation. A thin section of bone is removed from the lateral aspect of the adjoining os calcis and cuboid bones, and from the internal surface of the external malleolus, which may be further shaped to secure accurate apposition. The same, but more difficult, procedure is undertaken on the inner side. One separates the internal lateral ligament from the malleolus sufficiently to permit the complete backward displacement, then removes the cartilage from its inner surface. With the periosteal elevator the strong inferior calcaneo navicular ligament is detached sufficiently to permit the malleolus to sink in behind or to slightly overlap the navicular. Often the sustentaculum tali must be cut away to provide sufficient space for the broad, shallow internal malleolus. The two peronei tendons thoroughly freed from their attachments about the fibula are then passed through the base of the tendo-Achillis and sutured to it, and to the os calcis as well, at a sufficient tension to hold the foot in moderate plantar flexion. The tendo-Achillis is usually overlapped and sutured as an aid in restraining deformity. The Esmarch bandage is then removed, the part is thoroughly cleansed with hot saline solution, and the bleeding points are ligatured. The wound is closed with continuous catgut sutures, reinforced at several points with silk. The foot then carefully supported in its attitude of backward displacement and moderate plantar flexion with the malleoli fixed by slight pressure in their new relations, is thickly covered with sterilized sheet wadding and fixed by a light plaster bandage, particular care being taken to exert only the slightest constriction. The leg is then brought to a right angle with the thigh and the plaster bandage is continued over the thigh, reinforced by a band of steel in the popliteal region. The limb is then suspended for several days or a week, the aim being to relax tension and to lessen the oozing.

It may be noted that the essential modifications of the operation as originally described are, first, that the cartilage is no longer completely removed from all the exposed bones,

for as free motion always persisted it appeared to serve no purpose, while it increased the oozing, which if persistent interferes with rapid repair. Second, the more careful adjustment of the malleoli to their new position and the separation of the tissues attached to the internal malleolus and to the navicular bone to facilitate a complete backward displacement. Other variations have been tried, for example, lessening the thickness of the external malleolus if it appeared to project noticeably; sewing the external malleolus to the cuboid bone; splitting the tibia from below and forcing the anterior part forward to oppose a ridge of bone to the tendency to dorsal flexion. The above and like modifications are all of doubtful utility.

In cases of simple calcaneus the tendon of the tibialis posticus is sometimes transplanted to counterbalance the loss of the peronei.

The plaster bandage fixing the limb in flexion remains for several weeks until immediate repair is complete. It is then replaced by one that reaches only to the knee, holding the foot in the desired position of plantar flexion, the sole being made level by the insertion of a wedge of cork. The plaster support is worn for several months, the longer the better, since the patient must bear weight on the front of the foot until the adjustment and the formation of the new articulation are perfected.

Incidentally, the patient should be trained in the proper use of the foot, so that the equal gait may be restored. Although the cartilage is removed from the malleoli, ankylosis never follows. At best, there are fibrous adhesions that fix the parts in the improved position. The power of the transplanted muscles now exerted directly on the heel, although in no sense replacing that of the calf muscle, is sufficient under the new conditions to offset the deforming influence of the dorsal flexors, and in the absence of overstrain to hold the heel in proper position.

The after treatment will depend in great degree upon the resistance opposed to passive dorsal flexion and upon the

FIG. 1.



Talipes calcaneo-valgus during the developmental stage, showing the atrophied calf and the change in the contour of the heel. See Fig. 4.

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FIG. 2.



An X-ray picture of a foot after the author's operation, showing the changed relation of the leg and foot.

FIG. 3.



The method of fixing the foot in plantar flexion after the operation, by the plaster bandage and wedge.

FIG. 4.



The foot after operation and a simple brace to be worn within the shoe. See Fig. 2.

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strain to which the occupation of the patient is likely to subject the foot. In the adolescent class, if the limb is considerably shorter than its fellow, as for example, when the paralysis involves the thigh muscles, a so-called extension shoe is a satisfactory and easily adjusted support. In cases in which shortening is slight, a wedge of cork or other material within the shoe may be sufficient. Massage and proper exercises to improve the nutrition and to develop the muscles are of course of value.

In cases treated under ordinary conditions a light strong brace without joint at the ankle is worn within the shoe to hold the foot in moderate equinus. When this is rusted or broken, support is usually discarded.

In a large proportion of the cases examined for later results apparatus had not been worn, or had been discarded, yet the condition was very satisfactory. In no case was there valgus deformity. In several instances slight varus, caused apparently by transplantation of the peronei, was present, and in two cases of the dangle foot class it required correction. This would indicate that in certain cases of simple calcaneus transplantation of the tibialis posterior tendon might be of advantage. If, however, the external malleolus is forced well forward, the degree of varus can be but slight, and the cases in which valgus deformity was originally present it is rather an advantage than otherwise. In other instances the foot was habitually used in slight permanent dorsal flexion, but it was secure and symmetrical as regards prominence of the heel and depth of the arch. On the other hand, there were cases in which the muscular power was so well balanced and the gait so nearly normal as to almost merit the patient's verdict of cure. In cases in which support was used it was comfortable, easily adjusted and effective. In all cases the result was satisfactory to those immediately concerned, the improvement in the circulation of the limb and in its appearance being generally remarked.

Results such as these, obtained under the unfavorable conditions of hospital practice, should be improved in the

future by the more accurate adjustment of the parts in their new relation as in more recent cases, and still more if after-treatment and proper supervision may be assured as in the more favored class.

Talipes of the calcaneus type is comparatively uncommon and the operative method that has been described is still novel. Hoffa states, in the last edition of his text book, that he had employed it and that the results were "ausgezeichnet," but this is the only comment that has come to my notice.

As I have performed the operation in at least forty cases and have had opportunity to contrast the condition of the patients before and after treatment, I shall present and answer the criticisms that have occurred to me and which are, I assume, those that are likely to be made by others.

First.—The removal of the astragalus shortens the limb.

Second.—The operation is of a more serious character than the disability warrants, or the results justify, if a brace must still be worn to restrain deformity.

Third.—The operation may be indicated when lateral displacement is present, but it is not essential for simple calcaneus and it is not indicated when the characteristic deformity incidental to functional use (cavus) is not present.

The first objection may be answered by the statement that the removal of the astragalus is essential to the restoration of symmetry and to the attainment of security. In comparison, the slight shortening, practically never more than half an inch, is of no importance. Furthermore, the characteristic deformity of calcaneus lengthens the limb and the removal of the astragalus, which simply restores symmetry, shortens the limb only in the sense that reduction of equinus deformity shortens it; that is, if the limbs were of equal length there would be no shortening whatever. Finally, in characteristic calcaneus the fore foot is habitually above the level of the heel and plantar flexion of the foot is restricted or lost, but the space gained by the removal of the astragalus enables one to fix it in plantar flexion to the desired degree, thus to lengthen the shortened limb directly and to permit the application of the

compensating extension shoe or brace which before was impracticable.

The second question has been answered in part already, that after the correction of deformity a light and simple support may be efficient which before the operation would have been useless. The operation is, it is true, somewhat difficult and the danger would be increased by prolonged manipulation and injury of the tissues. The first should be unnecessary to one reasonably familiar with the anatomy of the part and there is no necessity for violence as no attempt need be made by wrenching, or otherwise, to change the shape of the foot; finally, the ease with which the wide wound may be drained should, in the event of infection, make the treatment simple as compared, for example, with arthrodesis. In my own experience I have not had cause for anxiety in any of the cases.

As to the third criticism. It is true, fortunately, that contrary to the rule, the operation is relatively most effective in the cases in which deformity and disability are most extreme. In my opinion, for the reasons given, it is indicated in all cases of lateral displacement and in all cases of calcaneus in which the characteristic cavus is well marked.

If deformity has been controlled by braces and if supervision and protective treatment can be assured, the operation may be deferred until the indications are clearer.

Fortunately, as has been stated, the more extreme the distortion the more satisfactory will be the result. It is this class only that surgeons are likely to encounter, and to them this operation is again presented with the assurance gained by an extended experience.